QUALITY ASSURANCE MANAGEMENT PLAN

FOR

DIGITIZED COMMON LAND UNIT

Prepared by
APFO CLU Team

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Executive Summary

The Aerial Photography Field Office (APFO) has participated in contracting, digitizing, and inspecting Common Land Unit (CLU) farm field boundaries for several county pilot projects. The experience gained in these pilot projects has provided APFO an insight on how to effectively manage and perform the quality assurance inspection of the estimated 3,100 counties requiring CLU digitizing services by the end of FY 2003. Based on APFO's experience, a management plan for CLU quality assurance, was developed for the purpose of providing information in support of USDA's Service Center Geographic Information System (GIS) initiative. The Quality Assurance Management Plan, presented in this paper, can be successfully performed at APFO by implementing the following recommendations:

1. Establish an organized structure of personnel, procedures, and responsibilities for the coordinated management of county mosaic production, CLU digitizing services, photomap preparation, and quality assurance inspection.
2. The APFO will perform quality assurance on all digitized CLU data using statistical sampling methods and automated verification techniques. The estimated labor cost for APFO QA services is $300.00 per county, for a total of $950,000 for all counties.
3. Provide adequate resources to maintain required production throughout the QA process and to maintain acceptable CLU accuracy levels. An additional six (6) FTEs, added to the current four (4) for a total of ten (10) FTEs, would be required to perform the QA services at APFO.
4. Contract out a major portion of the CLU digitizing work to private firms. The estimated cost of contracting digitizing work is approximately $10,000 per county, for a total of $31 million for all counties.
5. Standardize all county CLU source data, including ortho-imagery mosaics (no missing areas, same tile format), and photomaps correctly annotated according to the FSA 8-CM handbook.
6. Scan county photomaps into digital format for distribution and use in CLU digitizing.
7. Provide USDA Service Centers with software capability to edit, correct, and update digital CLU data.
8. Explore and develop other potential solutions regarding CLU data extraction directly from county photomaps.

The information contained in this document is provided for the purpose of identifying APFO's role and capabilities in performing the quality assurance of CLU data, and also to support and contribute to the planning and implementation of USDA's GIS system.

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1.0 Introduction

The Farm Service Agency (FSA) is in the process of implementing a Geographic Information System (GIS) in USDA Field Service Centers (Service Center) to automate the management of USDA Farm and Conservation Programs. To be of maximum use to FSA, the GIS will include a digital ortho-photography image base with pertinent cartographic features, farm tract and field boundaries, and associated farm records. It is the farm field boundaries, known as Common Land Units (CLU), and the related records, known as attribute data, that is the subject of this document. A process improvement team consisting of five members, each with specific knowledge and expertise, was formed to complete the assignment of determining the requirements for a quality assurance system for digitized CLU boundaries. The CLU Team prepared this document for the purpose of describing the Aerial Photography Field Office's (APFO) experience and capabilities in assisting FSA's farm field boundary digitizing effort, and to define requirements and forecasting information regarding an agency-wide CLU Quality Assurance Management Plan.

1.1 Background

For roughly sixty years FSA County Offices have organized and managed USDA farm records by manually delineating tract and field boundaries on 24 by 24 inch rectified aerial photo enlargements. These black & white photo enlargements are produced and rectified at APFO to an accuracy which allows Service Centers to delineate detailed tract and field boundaries and measure exact acreage of each. One of the challenges currently facing FSA is converting all this information into digital format to be used in an automated GIS. This conversion of imagery, farm boundaries, and other USDA information for use in a GIS will facilitate the efficient management of data and effective administration of programs. APFO and NRCS National Cartographic Center (NCG) are participating in the Acquisition Integration and Delivery (AID) project that acquires, integrates, and delivers geospatial data to service centers in a format ready to use.

APFO has taken the lead in providing FSA enhanced and reformatted digital ortho imagery for use in Service Centers. The digital ortho-photo quads (DOQs), purchased from USGS by FSA, are mosaicked into a single digital image of a county. The mosaicking process removes visible seam lines between individual DOQs and provides a consistent base to overlay the digitized farm field boundaries and soil surveys. Base cartographic data such as Public Land Survey System (PLSS), highways, railroads, and administrative boundaries is being provided by NRCS NCG.

APFO has also participated in pilot projects by providing digitizing, contracting and inspection services for county CLU digitizing projects. APFO contracted with three

vendors who were selected on a competitive basis to provide digitizing services. All three contracts, covering a total of eight county projects, were successfully completed and accepted. Contract administration information, including pricing, performance and quality issues, can be found in Appendix B. APFO performed the quality assurance services by inspecting every field and tract polygon and attribute data submitted by the contractors and correcting all errors found (100% inspection and correction). Additionally, APFO digitized CLU boundaries on a test county, Glades, Florida, and inspected the digitizing work for Miami County, Kansas, done by university students. The participation in all these projects has greatly improved APFO's knowledge, experience level, and capabilities regarding the understanding and development of a comprehensive agency-wide CLU quality assurance process.

1.2 Document Overview

The contents if this document have been organized into a logical sequence of topics that become more detailed as one progresses through it. The following is a list of sections and an overview of what each section contains:

Section 1.0 - Introduction. Identifies purpose, methodology, and background, as well as document overview.

Section 2.0 - Quality Assurance Management Plan Summary. Detailed synopsis of the CLU Team's findings, recommendations, and conclusions.

Section 3.0 - Quality Assurance Procedures. Defines current procedures and background, and proposed streamlined procedures.

Section 4.0 - Quality Assurance Process Requirements. Addresses five components required to define a CLU quality assurance system: 1) workload estimates, 2) data availability, 3) organization and structure, 4) computer system requirements, and 5) facilities.

Appendices. A - Definitions and Acronyms, B - CLU Contract Administration Information, C - A Sampling-Based Method for Inspecting Third Party-Produced Maps, D - FSA Handbook Common Land Unit Instruction, E- Proposed Photomap Scanning Solution.

1.3 References

U.S. Department of Agriculture Farms and Land in Farms Final Estimate 1993-1997. USDA

National Agricultural Statistics Service, statistical Bulletin Number 955.

2.0 Quality Assurance Management Plan Summary

This section summarizes the findings, recommendations, and conclusions that encompass the Quality Assurance Management Plan.

2.1 Findings:

The Aerial Photography Field Office CLU Team compiled data from the county pilot projects for CLU digitizing services APFO contracted and inspected. From these projects and associated research, the team analyzed the results and found the following:

- Of the total 3.6 million square miles covering all 3,141 counties in the U.S., only 1.5 million square miles, or 42% of the total, require CLU digitizing work based on land use in agricultural production.

- In order to digitize 1.5 million square miles of CLU boundary data by the end of fiscal year 2003, FSA will need to digitize approximately 375,000 square miles, covering 800 counties, per year.

- APFO's current capability of four (4) full time employees (FTE) with workstations could perform quality assurance inspection of this annual workload, but only by small sample inspections which may result in lower confidence levels.

- Quality assurance inspection of this annual workload, with 90% confidence level accuracy, can be achieved with ten (10) FTEs and workstations. APFO labor costs are approximately $300 for each county, for a total of $950,000 for all counties, based on estimates developed by the team.

- Complete 100% inspection of digitized CLUs is not economically nor logistically feasible due to limited resources. The recommended alternative is a combined automated and statistically sampled quality assurance system. Automatic validation and verification can be achieved through ArcInfo software programs and statistical sampling can be used to achieve a desired 90% accuracy result.

- Service Centers can expect to receive accepted CLU data with errors, based on the confidence level established for QA. The errors will require correction by Service Center employees when CLU data is delivered and installed. Service Centers should also have the capability of continually updating their CLU and farm records.

- There are potential problems with non-standard or missing source materials including photomap annotation and DOQ coverage that may have a negative impact on scheduling and contracting procedures. Standard photomap annotation and complete DOQ county coverage with standardized tile format are required for any contracted digitizing work.

- The average cost for digitizing services, based on contracts APFO awarded for the pilot county projects, was $10.53 per square mile, or approximately $1.00 per field digitized. The estimated cost to digitize an average county is $10,000, or $31 million for all 3,141 counties. Contract costs for CLU digitizing will vary depending on the density, size, and patterns of fields in any particular county. Rectangular shaped, large fields, in high regular densities (Kansas) may be priced much less than irregular shaped, small fields (Tennessee).

2.2 Recommendations:

In order to successfully deliver both the mosaicked ortho-imagery and the inspected digital CLU data to the Service Centers, it is critical to have an organized, coordinated plan and schedule of county mosaic production, digitizing and inspection of the CLUs, and availability of the source photomaps. Please refer to Figure 2.0 CLU Process Flowchart. The following are recommendations to achieve successful CLU quality assurance results:

- Develop a comprehensive plan for the systematic and coordinated delivery of county mosaics and inspected digital CLU data to the Service Centers.

- Establish a management team, whose members represent each component source (county mosaics, source photomaps, digitized CLUs), to prioritize, organize, and coordinate delivery of all required products to the Service Centers.

- Establish APFO as the CLU Quality Assurance Center to perform inspections on digitizing work submitted for all counties.

- Provide APFO the funding and equipment for an additional 6 FTEs, for a total of 10, to perform quality assurance inspections required for the estimated work load at the required accuracy levels.

- Divide portions of the CLU digitizing workload between the FSA Digitizing Centers and private contractors, in order to accomplish USDA's goals and deadlines.

- Prioritize and schedule a) county mosaic production according to availability of Digital

Ortho Quadrangles (DOQs), and b) digitizing of CLU boundaries according to availability of the county mosaic and photomaps.

- Scan all county source photomaps to reduce costs, minimize time out of use, and improve availability for coordinated delivery system.

- Identify non-standard photomap sets and route materials to regional digitizing centers where interpretive skills may be utilized. (Digitizing services contracts must have standard photomap annotation).

- Furnish both mosaicked ortho-imagery and scanned photomaps to digitizing centers or contractors as a complete package according to the coordinated schedule.

- Provide Service Centers with the capability to correct final CLU data. There will be some errors accepted in the QA process from Digitizing Centers and contractors.

- Explore other potential solutions as alternatives to digitizing CLU data from county photomaps. Using advanced feature extraction techniques, CLU data may be extracted directly from scanned county photomaps. APFO and others are researching the possibility of utilizing this technology.

2.3 Conclusion:

The Aerial Photography Field Office is prepared to offer CLU quality assurance services to our fullest capacity. Whether it is accomplished with existing or additional resources our employees have always welcomed new challenges with successful results. FSA can rely on APFO to support the mutual goals of the Agency and Department.

3.0 Quality Assurance Procedures

This section describes quality assurance procedures used by APFO to inspect the pilot county CLU projects and describes the proposed procedures to be used on future CLU projects. Since the current procedures have been developed based on a small sample size of pilot county projects, it is expected that future procedures and processes will incorporate numerous process improvements and economies.

3.1 Pilot Projects Background

APFO began performing quality assurance on CLU projects in the Fall of 1998. County based CLU digitizing projects were submitted for inspection by private contractors and other sources. The following quality assurance procedures developed by APFO are based on the 100% inspection and correction performed on all work submitted as well as digitizing test projects done by APFO. It is assumed every county in the U.S. will have digitized CLU data to be inspected in support of the USDA GIS initiative.

3.2 QA Procedures for Pilot Projects

After receipt of original source photomaps, county mosaic, and CD ROM containing the CLU data, delivered from the contractor, the general guidelines listed below defining the quality assurance inspection procedures were followed :

3.2.1 Setup

QA Inspectors organize source photomaps into flight line order North to South and West to East. Inspection is started with the first photomap located at the North and West corner of the county. The county mosaic and CLU data CD ROMs are loaded into a workstation and initial formatting and preparation programs run through ArcInfo software.

3.2.2 Pre-Inspection

Inspectors view the digital county mosaic imagery with the CLU data overlay by roaming from one township to another and looking for "general quality" of digitized tract and field boundaries and comparison of line work to imagery to see if objects appear to be in alignment and correctly located. When a tract of land or a farm field is delineated in a digital format, the enclosed area is referred to as a polygon. The tract and field attributes, which define characteristics such as ownership, are attached to the polygon.

3.2.3 Inspection

Inspectors work in a "heads-up" environment utilizing the computer screen and photomaps to check the quality and accuracy. Using the ArcView program, the inspectors proceed to locate specific polygons and match them to the same area on the photomap. Then using the cursor to highlight the polygon, the digitized boundaries lines and attribute data are checked for accuracy which must meet contract specifications. If digitized polygon lines fail to match the mosaic image features within 3 meters, using the photomap as a reference, an error is detected and corrected through a line editing function of ArcView. The digital attribute data is checked by displaying it in a "check/update" window, and compared to the information on the corresponding photomap.

3.2.4 Error Tolerance

If error rates exceed 5%, the materials are shipped back to the contractor for rework and corrections. If there are less than 5% errors, the inspector corrects the digitizing and attribute data at the time it was found to be in error. All county pilot projects were 100% inspected and corrected.

3.2.5 Acceptance

Upon acceptance of the CLU data, all materials (county mosaic, CLU data, and photomaps) are shipped to the Service Center and the contractor notified of final acceptance.

3.3 Proposed QA Procedures

The time constraints and limited resources make accomplishment of a 100% quality assurance inspection and correction unfeasible given the magnitude of the CLU initiative. Therefore, APFO proposes to reduce costs and optimize data confidence and quality through statistical sampling techniques. Service Center personnel must anticipate a certain amount of errors in the boundary and attribute data depending on the standard rate of sampling and level of confidence to be determined. Errors will occur and be undetected even at a 100% quality inspection level. Proposed QA procedures are expected to be accomplished by the following:

3.3.1 Validation Check

This is an automated process through which the ArcInfo program will validate the correctness of the CLU data structure and content. It checks if polygons meet specified standards and whether they're properly attributed. This process does not however, assure all data is accurate. A feature may conform to structural standards but still be incorrect either because it is in the wrong place or because it has valid but incorrect attributes.

3.3.2 Verification Check

Verification of the converted data is performed by visual inspection of digitized farm and tract fields, non-agriculture areas, and attribute data attached to each. The inspector will be verifying this data through statistical sampling techniques assuring that all polygons are correctly located and all attribute data is correct according to the source photomaps. The regions sampled will be thoroughly inspected for errors and depending on rate of errors, be verified as correct or rejected and returned to the contractor for corrections.

3.3.3 Spatial Sampling

APFO will perform QA on spatially sampled portions of each project based on inspection of more densely feature regions. It will take into consideration weighted factor sampling of elements to determine higher concentrations of fields within the county. Random samples of field attribute data and boundary delineations will be viewed within this population. Samples will be based on populations of "fields" and not polygons.

3.3.4 Sample Size

Because each county contains different concentrations of fields, sample sizes will vary by county. Sample size will be determined by using the following formula:

$$\frac{\text{(Population of fields) (1)}}{\text{(Population of fields - 1) (confidence coefficient) + 1}}$$

Example: If an average county contains 12,530 fields, and a 90% confidence level is desired, then: (12,530)(1) / (12,530 -1)(0.000652) +1 = 1,535 fields sampled, or a 12% sample.

3.3.5 Confidence Level

A Confidence Level of 90% would result in a project having up to 10% errors and is considered acceptable and attainable at the present time. However, as inspections proceed and increase we may have to modify that level up or down to meet time and/or staffing constraints. Our goal is to reach as high a confidence level as possible.

4.0 Quality Assurance Process Requirements

This section identifies the anticipated workload estimates and schedules, the projected staffing requirements, and describes the hardware and software environment provided to perform quality assurance inspections for CLU.

4.1 Workload

Workload estimates and schedules are based on inspecting only mosaic tile images of land in use for agricultural purposes. According to the most recent farm use statistics from USDA, National Agricultural Statistical Service (Statistical Bulletin Number 955), there are 956,010,000 acres or 1,493,766 square miles of land in agricultural production. There are 3,141 counties needing CLU data conversion to be inspected. It is expected that all inspections will be completed by the end of fiscal year 2003.

4.1.1 Estimates

The quality assurance of the pilot projects was completed by visual 100% inspection of the digitized line work. It is estimated, based on QA of pilot projects, that an inspection of any county or project can be performed at a rate of inspecting an area of 5 square miles per hour. A confidence level of 90% accuracy of the digitized line work data can be achieved by inspecting approximately 10 percent of the agricultural areas. The following chart shows estimates of hours and staffing required over a four year period, for a given percent inspection:

Percent of County Inspected	Square Miles Inspected	Estimated Hours (5 sq mi/hr)	Setup, Document, 10% Re-inspection	Total Hours	Estimated Number of FTEs per Year
5	75,000	15,000	18,500	33,500	6

10	150,000	30,000	20,000	50,000	9
100	1,500,000	300,000	47,000	347,000	60

Figure 4.1.1 Estimated Hours and Staffing Requirements to Inspect all Counties.

APFO has performed the QA inspection of CLU data on the pilot projects with 2 full time employees (FTE). With reassignment of duties to other sections within APFO, 2 more full time employees could be added for a total of 4 FTEs. It is estimated, as shown by the previous chart, that there needs to be at least 6 FTEs to do a 5 percent sampling resulting in confidence levels below 90% accuracy, and 9 FTEs to do a 10 percent sampling resulting in confidence levels at or above 90%. At APFO current staffing levels, only 38 to 57 percent of all counties could be inspected by the end of FY 2003. Currently, the APFO can dedicate 4 workstations to the inspection of CLU data. If staffing can be dedicated to all 4 workstations, approximately half of all the counties could be inspected by the end of FY 2003 at less than acceptable accuracy levels.

4.1.2 Schedules

The proposed Quality Assurance Schedule is based on beginning full QA inspection work in FY 2000 and continuing through FY 2003 (four years). The QA Schedule will be directly influenced by the county mosaic production schedules of the Digital Service Section of APFO, which produces the mosaic tile image from the USGS Digital Ortho Quadrangles (DOQ). The Digital Service Section's schedule will in turn be directly influenced by USGS's production and availability of DOQs. The FSA Regional Digitizing Centers and Private Contractors must have the mosaic tile image, and the source photomaps, in order to digitize the CLU data.

The Digital Service Section currently estimates at current staffing and equipment levels, that 350 to 425 counties will be mosaicked in FY 2000, increasing to 550 to 650 counties per year by FY 2003. With the possibility of increased staffing and equipment, the number of counties mosaics could be 700 to 800 per year.

The FSA Digitizing Centers are expected to be able keep pace by averaging as high as 10 counties a month at each of the 6 Digitizing Centers. This is based on each Digitizing Center having 5 workstations and each workstation capable of averaging two digitized counties per month.

4.1.3 Workflow

Inspections are expected to keep pace with the CLU data production, because of the sampling methods to be used. It is assumed that in the earlier part of this project to inspect CLU data a higher percentage of area will be sampled and a higher number of counties will be rejected. Digitizing Centers will continually improve the quality of their product and will require less inspection over time. A higher volume of counties could be inspected over time because the sampling could be reduced, and the inspection process would be able to keep pace with the higher number of counties expected in FY 2002 and FY 2003.

4.2 Data Availability

The FSA Regional Digitizing Centers and Private Contractors who will be performing the CLU data conversion must have available two components in order to digitize the CLU data: the mosaicked ortho-image tile, and the source photomaps

4.2.1 Ortho Imagery

FSA has been a partner in the National Digital Ortho Program (NDOP) for many years and has contributed to the funding for the production of Digital Ortho Quarter Quads (DOQQ). This program is administered by USGS. The DOQQ imagery will be used as the base image layer in the Service Center GIS. APFO is acquiring this imagery and creating seamless county mosaics, which the digitized CLU data must match. The availability of the images is depended upon USGS and USGS contractors who convert aerial photography into ortho-imagery. It is imperative the DOQQs be completed in a timely manner in order to allow APFO time to mosaic the images for delivery to the Digitizing Centers or contractors. The ability to create county mosaics and to then digitize the CLU data is depended upon the DOQQ's being completed. The schedule established by USGS, is to make available complete coverage of the U.S. by the end of FY 2003. Funding, availability of aerial photography, and delays from contractors can be some of the issues USGS may face in not being able to meet the established schedule.

The impact of not having enough DOQQ's to complete the coverage of a particular area, will effect the Digital Service Section of APFO (DSS) from being able to mosaic and tile that area. Thus, the Digitizing Centers or contractors would not be able to create the CLU data for that area, and a smaller number of projects would be produced, and would delay the inspection of that area. Any delays by USGS, whether by not completing the DOQQ's on schedule, or not delivering the DOQQ's in a timely manner, can and will impact the delivery of the mosaics and CLU data, thus impact the workload to the QA inspection of the CLU data.

4.2.2 Source Photomaps

Source photomaps are the materials provided to the digitizing centers or digitizing contractors that have the field and tract (CLU) Common Land Unit boundaries defined by different colored lines. Currently, the only way to digitize the CLU into digital format is to have the Service Center ship their original source photomaps to APFO to be distributed to the contractor. The future plan is to have the Service Center ship their source photomaps directly to the digitizing center. This is an inconvenience to

the counties since many of their programs are dependant upon the information contained on the photomaps.

4.2.2.1 Time Out Of Use

The approximate time to digitize the data on the source photomaps is approximately two (2) weeks, or 80 hours. The photomaps will also be required from three (3) to five (5) days at APFO for the Quality Assurance inspection. Include an additional six (6) days time for shipping to and from destinations (if photomaps are shipped via express overnight, longer if not). The estimated minimum time out of use would be from three (3) to four (4) weeks. Precise scheduling of photomap shipments and location tracking will have to be coordinated between the digitizing providers and the APFO. This amount of time, in many instances will interfere with the Service Center's work. The only real "non-critical" time out of use would be in the winter.

Note: See Appendix E, Proposed Photomap Scanning Solution. Potential solution of minimizing the time photomaps are out of use.

4.2.2.2 Standards

General standards for the delineation of farm field and tract boundaries on source photomaps are as follows:

a. Tract and/or field boundaries are outlined in red. They should follow the physical visible features on the ground with the defined feature.
b. Each tract and/or field should have a tract, farm, and field number, with the NRCS's Highly Erodible Land (HEL) identifier .

The digitized features and their attributes shall meet the following criteria:

a. Line work (tract and/or field boundaries) must be within 3 meters from the defined feature on the digital image.
b. Attributes: Where the HEL identifier exists, enter as listed on the source photomaps. Tract number (Beginning with a "T") entered as annotated on the photomaps. The same follows for the Field and Farm numbers. This data shall be entered into the attribute list exactly as on the photomaps.

Note: See Appendix D, FSA Handbook 8-CM, Common Land Unit Instruction.

4.3 Organization Structure and Responsibilities

This section describes the organizational structure and individual responsibilities including the outside interfaces for performing CLU inspections.

4.3.1 FSA Coordinator

The FSA Coordinator position is responsible for:

a. Scheduling and monitoring work progress at regional digitizing centers.
b. Identification and re-distribution of non-standard CLU data on photomaps.
c. Coordination and scheduling of source photomap distribution to destinations.

4.3.2 Contract Coordinator

The Contract Coordinator position is responsible for:

a. Solicitation and award of contracts to private vendors for digitizing services
b. Scheduling and monitoring work progress by contractors.
c. Coordination of delivery schedules.

4.3.3 APFO Coordinator

The APFO Coordinator is responsible for:

a. Management of work flow from the digitizing centers and contractors through the APFO quality inspection and back to the service centers.
b. Working with digitizing center personnel and/or digitizing contractors to schedule shipping of materials shipped to and from the APFO.
c. Ensuring the receipt of all materials is recorded.
d. Scheduling the Quality Assurance priorities.
e. Providing management reports on the progress of the quality checks.
f. Assign CLU Inspection Team Leader

4.3.4 Inspector(s)

The Inspectors are responsible for:

a. Performing quality assurance inspections of counties assigned to them.
b. Interpretation and comparison of photomaps to CLU data in a digital environment.
c. Preparing inspection and status reports.
d. Securing equipment and data.

4.4 System Requirements

This section describes the computer hardware and software requirements for a QA inspection system.

4.4.1 Configured Hardware Environment

The following is a description of existing computer hardware equipment currently installed or scheduled for installation at APFO.

4.4.1.1 Workstation Disk Space

The physical disk space required for edit corrections is as follows:

Average Size of County CLU Data File	Average Disk Space Needed for Digital Imagery	Average Total Disk Space Per County Being Edited
10 MB	3.5 GB (3,500 MB)	4 GB (4,000 MB)

Figure 4.4.1.1 Disk Space Requirements

As shown in the table, each workstation requires at least 4 Gigabytes (4,000 Megabytes) of disk space for application use only. That is, this disk space will be used only for imagery and CLU (Common Land Unit) data. This disk area too, must be partitioned to be a single partition (area) so the editing process will not be affected by split disks / partitions. The limitations listed above do not include disk space needed for the operating system and the GIS software. This will require at least 1.5 Gigabytes of additional space. The hardware too, must be networked to a central networked server environment in the event that the county being edited exceeds the internal limitations of the computer, thus allowing the user to use wider range of resources. Input devices should consist of the minimum requirement.

4.4.1.2 Workstation Configuration

Currently there are 4 dedicated workstations with the following configuration:

Operating System - Microsoft Windows NT 4.0

300mhz Pentium II class CPU
64 MB SIMM or DIMM RAM
8 MB of video RAM
8 Gigabyte Hard Drive space
32x CD-ROM
21" high resolution monitor (1268 x 1024 DPI)
100 BaseT Full duplex network connection

There is one shared device that has the following configuration:

Operating System - Unix: Solaris 2.x (2.5.1, 2.6, or Solaris 7)
X-Terminal device
64 MB RAM
21" high resolution monitor (1268 x 1024 DPI)
100 BaseT full duplex network connection
8 Gigabyte Hard Drive space/per X-Terminal

These systems require some shared resources or servers. The servers will handle the actual licenses and software administration. One of dedicate NT workstations would also be used as a server will have 56 MB SIMM or DIMM RAM. The devices that use shared resources will require 4mm tape drives.

4.4.2 Configured Software Environment

The software being used for the Common Land Unit (CLU) quality assurance has the following capabilities:

a. Reads multiple vector data sets
b. Displays multiple large raster (image) files either independently or cataloged
c. Changes the attributes of a polygon feature
d. Adds new attribute item (feature) to a polygon layer
e. Changes the lifework of a polygon in the event a line falls outside the maximum allowable tolerance (3 meters) for field/tract boundary line placement.
f. Adds vector data in the event a field/tract boundary is missing during the initial digitalization of the Common Land Unit (CLU)
g. Develops custom programs to ensure standardized editing procedures.
h. Ability to build topology for each vector data set. No overlapping lines, duplicate arcs, miss- or un-labeled polygons, etc.

The criteria listed above is a representation of the necessary functions of a Geographic Information Systems (GIS) software for CLU editing. Currently, APFO has five (5) licensed copies of ESRI's ArcView 3.1 GIS software (4 UNIX platform, 1 Windows N/T platform). We are scheduled to receive three (3) new licenses (Windows N/T

version) of ArcView 3.1, with server. This will increase our licences to seven (7) total. However, ArcView 3.1 does not meet the criteria as listed above. The "build topology" item (h) is a necessary function to meet the Geospatial Data Standards. APFO has used ArcInfo version 7.2.1, which meets the Geospatial Data Standard, to inspect and edit the CLU data for the pilot projects.
Like ArcView, ArcInfo can be easily programmed to meet the custom needs of inspectors using Formedit and Arc Macro Language (AML). ArcInfo has the ability to change any or all lines, attributes, nodes, and topological structure of a coverage (layer). It ensures that all features are properly designed and meet any and all geospatial data standards.

4.5 Facility Requirements

Workareas, including workstations, will be located within APFO's building structure in Salt Lake City, Utah, and will have the following characteristics:

a. 63 square feet of workspace of which 24 square feet is table top space
b. Workstation and other equipment to be secured
c. Physical location of workareas provided security
d. Three foot depth to line up monitor, keyboard and wrist guard
e. Mechanism for adjusting monitor height
f. Lighted adjustable easel with lip to hold 24x24 photomap
g. Area under easel for storage of photomaps
h. Two locking lateral file cabinets

Appendix A
Definitions and Acronyms

Definitions and Acronyms

APFO: Aerial Photography Field Office

CLU: Common Land Unit (see FSA Handbook 8-CM)

County Mosaic: A compilation of digital orthophotography that has been electronically joined together on a common seam line. This compilation of imagery is then matched tonally to represent the county area as though it were one, continuous image. After joined (seamed) together and tone matched, image tiles can then be extrapolated from the mosaic.

DOQ: Digital Ortho-photo Quadrangles

DOQQ: Digital Ortho-photo Quarter Quadrangles

ESRI: Environmental Systems Research Institute

Field: A polygon feature that contains information regarding which *tract* it belongs to, *acreage* amounts, *HEL* (Highly Erodible Land) status and *farm* number. areas of agricultural significance. Non-agricultural lands do not count as fields. Fields are defined as parts of a farm that is separated by relatively permanent boundaries such as fences, permanent waterways and woodlands.

FSA: Farm Service Agency

FTE: Full Time Employee

GIS: Geographic Information Systems. A program that runs on a computer that allows a user to analyze the earth's features using data derived from various sources and models. Information can be in the form of points (well locations), polygons (fields/tract boundaries), lines/arcs (rivers), and imagery (orthophoto mosaics)**.**

HEL: Highly Erodible Land

MrSID: A digital image compression software developed by LizzardTech, Inc. that stands for Multi-Resolution Seamless Image Database. (*see http://www.lizardtech.com)*

NDOP: National Digital Ortho Program

NRCS: Natural Resources Conversation Service

Photomap: 24" X 24" aerial photo enlargement source document that contains the CLU information.
Polygon: A feature class in a GIS used to represent an area. Polygons have a single point that define the geographic space and tabular information regarding the area represented. This point contains the

"attribute" information for that area. For polygons to exist, the line work that makes up the polygon boundary must be closed and solid with no "leaks"

PLSS: Public Land Survey System

QA: Quality Assurance: The process of assuring the quality of a product or service received meets an established set of requirements or specifications. As used in this document, the process of inspecting the digitized CLU boundaries and attribute data, submitted by a provider, for detection of errors, omissions, or other deficiencies.

QC: Quality Control: The process of controlling and maintaining a level of quality in producing of furnishing a product or service. As used in this document, the process of detecting and correcting errors as the CLU boundaries are digitized by the provider.

RD: Rural Development

Service Center: A USDA Field Service Center that houses the Farm Service Agency (FSA) personnel/representatives, the Natural Resources Conservation Service (NRCS) personnel, and the Rural Development (RD) personnel/representatives. Each county in the United States is represented by one Service Center and the personnel from each respective agency therein.

Sliver Polygon: This is a polygon that has no representation on the photomap. A sliver polygon meets the criteria of a polygon as described above, but has no attributes that define the features of a field. Sliver polygons are usually less than 10th of an acre.

Tract: A polygon that consists of one to many field boundaries. A tract may contain areas of agricultural significance (farmed land) and/or non-agricultural areas. (Example of non-agricultural lands: Trees, brush and rock outcroppings, ditches, homesteads, buildings, etc...)

USDA: United States Department of Agriculture

USDA Field Service Center: See Service Center.

USGS: United States Geological Survey

Appendix B
CLU Contract Administration Information

Appendix C
A Sampling-Based Method for Inspecting Third Party-Produced Maps

Appendix D
FSA Handbook 8-CM, Common Land Unit Instruction

Appendix E
Proposed Photomap Scanning Solution

Proposed Photomap Scanning Solution

A Cost Benefit Analysis

Benefits to Scanning Photomaps for use in CLU Conversion:

The average shipping cost to ship photomaps Federal Express (FedX) Next Business Afternoon is $40.00 per full box. Each county has approximately 4 boxes. This will amount to a total of $160.00 per county, one way shipping. Take into account the shipment from the Field Service Center to the Digitizing Center, and from the Digitizing Center to the APFO and finally, returning the photomaps to the Field Service Center, the shipping cost will be an average of $480.00 for all ways.

Other potential adverse concerns include:

a. The possibility of lost shipments - from all points of sending and receiving
b. Lost photomaps during the digitizing and/or editing process
c. Inconvenience to the Field Service Center for keeping their photomaps for an extended time. (4 weeks)
d. Damage to photomaps during the shipment, digitizing and/or inspection process
e. Partial shipments from all shipping/receiving points which would drastically reduce the turn-around time the Field Service Center would receive both the digital product and the photomaps for the service center.
f. Storage concerns. Consider that each photomap box acquires 4 square feet (24" x 24"). If each county has approximately 4 boxes of photomaps, and we have the potential at the APFO to edit approximately 6 counties per week, there will be approximately 24 boxes of photomaps per week. The chance for mixing an order, or loosing photomaps will be increased significantly as time and productivity increase at both the Digitizing Centers and APFO.

The scanning solution would prove cost-beneficial for the CLU digitizing initiative by reducing shipping costs, reducing turn-around time (to all involved with the CLU process), and reducing overall digitizing time. The only significant cost would be the time, labor, and equipment cost invested to scan the photomaps.

Recommendations:

Option 1: It is recommended that APFO receive at least four (4) color scanners to scan the USDA Field Service Center's photomaps. This would allow all photomaps to be scanned to a standard that would give universal results throughout the country. This would also standardize and prevent any differences in scanned photomaps used for heads-up digitizing. By having the APFO provide the scanning service, each county would know exactly where to send their photomaps, and the amount of time they could expect their photomaps to be away from their office. This would eliminate any confusion of where to send the photomaps or the amount of time out-of-use, and would significantly reduce shipping costs associated with photomaps. This

recommendation would allow the digitizing centers to run on a minimal staff to digitize the CLU without the extra burden of scanning a county's photomaps. Since APFO has adequate staffing to perform this function, and has the equipment necessary for the creation of CD-ROMS for distribution, it seems APFO is the likely candidate for this task. If this recommendation is adopted, APFO will scan the photomaps, verify the scans and create the CD-ROMS of the scanned photomaps to be used in both the heads-up digitizing and the quality assurance process.

Option 2: It is recommended that each Digitizing Center would receive at least one scanner to do the scanning of the photomaps. This would allow the possible mistake of missing a photomap during the scanning process to be fixed quickly, since the Digitizing Center is located in or near the state being digitized. It too, would not allow any incomplete data to be released to the APFO for final edit. It too, is recommended that the APFO receive one scanner to help in the scanning process during heavy, or peak times when the Digitizing Centers are to capacity. Since the source documents (Source Photomaps) will be in the digitizing centers and the APFO for approximately one month [(4) four weeks], a recommended solution to speed up the process of digitizing and editing would be to scan the source documents (Source Photomaps) and write the digital scans to a CD-ROM. This information could then be forwarded to the APFO and used to inspect CLU data. The projected minimal time the source documents (Source Photomaps) would be away from the Field Service Center (FSC) is approximately 4 days. This amount of time is based on the following table:

Shipping Time Roundtrip	Average Scans per County	Scan Setup	Time per Scan	Total Scan Time per County
2 days.	250 Scans 1000 sq. Miles / 4 sq. miles per source doc.	15 Minutes	Approx. 1 Min. (45 sec. scan & 15 sec. load)	Approx. 5 hours.

Time Out of Use Estimates for Scanning

FYI: The scanner tested is an Annatech 3440 Color scanner with a 200 MHz CPU with 32 MB RAM, 8MB Video card and Windows N/T 4.0. Resolution of Scan: 200 dpiDate of Test: April 9, 1998

The cost of the scanner with the workstation and the software is approximately $40,000.00. The scans that would result could then be converted to a MrSID format. These images could then be viewed using the MrSID Viewer, while digitizing and/or making any corrections to the Common Land Unit vector data set.